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ABSTRACT

Problem-based learning (PBL) is often promoted in response to the current need to offer authentic and effective professional education. PBL is a curriculum development and instructional system that simultaneously develops both problem solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem solvers confronted with an ill-structured problem that mirrors real-world problems. Traditionally, PBL is used in face-to-face environments, with a facilitator guiding collaborative teams of students in solving a problem. This paper provides a discussion of the theoretical and methodological implications of designing a problem-based professional development system on the Web, and describes an instructional design model for designing such a system, called the Learning to Teach with Technology Studio (LTTS). This model should help instructional designers better understand the theory and methodology of online problem-based learning and enable them to adapt it as needed for their own online learning environments. The model should also help support new models of professional development for K-12 teachers. Before discussing the instructional model used in the design of LTTS, the theoretical framework that was used as the basis for its development is addressed. (Contains 46 references.) (AEF)

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An Instructional Design Model for Online Problem Based Learning (PBL) Environments: The Learning to Teach With Technology Studio

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1

Abstract

This paper provides a discussion of the theoretical and methodological implications of designing a problem-based professional development system on the Web as well as describes an instructional design model using problem based learning (PBL) principles. The purpose of the paper is to help instructional designers understand the methods used by the LTTS team in developing and structuring PBL on the Web.

Background

Telecommunication networks are changing the nature of teaching and learning. In the past decade, Web-based learning has experienced rapid growth in various educational arenas. From corporate training to K-12 and higher education, many educational providers are now providing online courses and learning modules so learners can gain access to education anytime and anywhere there is an Internet connection.

Currently, more than 50,000 university courses are taught online, and 1,000 universities developing and offering these online courses (Carnavale, 2000; National Center for Education Statistics, 1999). Nearly all of Fortune 100 companies already offer some form of online computer-based training (Herther, 1997), and this will continue to increase as the demand for stand up training decreases rapidly (ASTD, 2000).

A need for periodic professional development has contributed to the demand for more flexible access to higher education. Organizations and institutions are increasingly offering online professional development opportunities to educators (Mather, 2000, Schrum, 1999). In current times, continual reskilling is a fact of life (Bonk and Wisher, 2000), especially for teachers who must keep up with new teaching strategies, the latest professional standards, and constantly changing technologies. Coincidentally, new technologies promise to facilitate access to learning at times and places chosen by the learner (Albion and Gibson,1998). These web-based environments have the potential to transform teacher professional development through the use of new models of teaching and learning. Online environments also have the potential to facilitate a sustained culture of sharing, collaboration, mentoring, and support for K-12 teachers.

With the rapid rate of expansion of online education, there has also been a call for a renewed focus on understanding and improving online teaching and learning. As a result, institutions are designing and implementing new models of distance learning environments (Institute for Higher Education,1999). The goal of these learning environments is to promote learner engagement using inquiry and problem solving. One such methodology being implemented online is problem-based learning. Problem-based learning (PBL) is often promoted in response to the current need to offer authentic and effective professional education. Jonassen (1991) argues that "the most effective learning contexts are those which are problem or case based and activity oriented, that immerse the learner in the situation requiring him or her to acquire skills or knowledge in order to solve the problem or manipulate the solution" (p. 36).

Problem-based learning is a curriculum development and instructional system that simultaneously develops both problem solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem solvers confronted with an ill-structured problem that mirrors real-world problems (Finkle and Torp, 1995). Traditionally, PBL is used in face-to-face environments, with a facilitator guiding collaborative teams of students in solving a problem. PBL was initially developed at McMasters University in the late 1960s. It is used in a wide variety of educational environments including medical education (Barrows, 1985), business administration (Stinson and Milter,1996), schools of education (Bridges and Hallinger,1992), undergraduate education (White,1996), and K-12 schools (Barrows and Myers,1993). Problem based learning environments are often reported to increase student

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2 BEST COPY AVAILABLE

motivation, to help develop critical thinking skills, to increase use of outside learning resources, and to increase understanding of content knowledge in context of its use (Albanese and Mitchell,1993, Torp and Sage, 1997).

As traditional PBL has naturally expanded to many curricular areas, it has also expanded to the online educational arena (Stinson and Milter, 1996; Oliver and Omari, 1999; Pankratz, 1998; Naidu and Oliver, 1996). Yet online learning environments are new, and principles for the design of instruction in this environment are just emerging [Duffy, Dueber, and Hawley, 1999; Bonk et al, in press]. This means that instructional designers are the first who face the challenge of incorporating PBL approaches into the Web structure.

Heath (1997) recognizes a trend in instructional design towards replacing traditional behaviorist approaches with constructivist orientations emphasizing the use of emerging technologies. Therefore, understanding how to design and support the online problem based learning process is critical to the effectiveness of such online learning systems. Since few instructional designers have experience in developing problem based instruction for a Web based learning environment, it is critical that we provide instructional models focusing on the design of online problem based learning systems.

In this paper, we provide an instructional design model for designing a problem-based professional development system on the Web, called the Learning to Teach with Technology Studio. This model will help instructional designers better understand the theory and methodology of online problem based learning and enable them to adapt it as needed for their own online learning environments. This model will also help support new models of professional development for K-12 teachers. Understanding how to design online professional development systems for in-service teachers is important given recent recommendations from the professional development literature. The design of these online learning environments presents unique opportunities for transforming current models of preK-12 professional development. "Rather than having information delivered to them, teachers need to examine their beliefs about subject matter, student learning and instruction in the light of innovation" (Marx, Blumenfeld, Krajcik, and Soloway, 1998, p. 33). These models build on continuous inquiry, integration of new ideas with colleagues, and reflective practice, which are critical elements of successful professional development (Shanker, 1990).

Theoretical Framework

Before we discuss the instructional model used in the design of the Learning to Teach with Technology Studio, it is important to address the theoretical framework that was used as the basis for its development. Constructivism served as the guiding theoretical framework for the development of this instructional model. Constructivist theories of learning posit that knowledge evolves through social negotiation and through the viability of individual understandings, that understanding come from our interactions with the environment, and that cognitive conflict or puzzlement is the stimulus for learning and determined the nature of what is learned (Duffy and Cunningham,1996; Savery and Duffy, 1996).

During the past several decades, there has been an important shift in the way we view knowledge as well as the process of learning. Knowledge was once viewed as a known set of discrete *facts* to be *acquired* during the learning process via a simple process of *inputting information* into a learner 's head. Within a Constructivist framework, the focus is on the role of the learner. Rather than simply acquiring existing knowledge, the learner constructs knowledge through a complex set of interactions with the environment, culture, negotiations with other people, and tools (technological and otherwise) used in the process of learning. As learners engage in the social construction of knowledge, meaning, practice, and context are inextricably woven together (Lave and Wenger, 1991; Naidu and Oliver, 1996). Savery and Duffy (1996) link the theoretical principles of constructivism with the methodology of problem based learning as follows:

- Learning should be relevant
- Instructional goals should be consistent with the learner's goals.
- Cognitive demands and tasks in the learning environment should be consistent with cognitive demands and tasks for the environment for which the learner is being prepared.
- Teachers' role is to challenge the students' thinking.
- Students' ideas should be tested against alternate views through social negotiation and collaborative learning groups.
- Encourage reflection on the learning process (p.137).

By using Constructivist theories of learning as the basis for the development of this instructional model, we considered the role of the learner, the knowledge construction process, and the learning environment. By using the principles of Constructivism to guide the development of an online problem based learning instructional model, we

can design educational environments that further develop learners' critical thinking and problem solving abilities, content knowledge, skills, strategies, and learning processes.

The Learning to Teach with Technology Studio

In order to understand this instructional model, it is first necessary to understand the context in which this instructional model was created. In 1999, Indiana University's Center for Research on Learning and Technology received a grant from the Department of Education to develop the Learning to Teach with Technology Studio (LTTS). The LTTS is a web-based professional development system to help K-12 teachers learn to use technology to support student inquiry and problem solving. (See **http://ltts.org** for more information). The LTTS is being developed to address needs of K-12 inservice teachers who lack skills and confidence in integrating technology into their teaching. While the technology infrastructure grows — 51% of classrooms are wired for Internet access, and there is one computer for every 5-7 students (National Center for Education Statistics, 1999; President's Panel, 1997) — the ability to use it lags. The Milken Exchange (Solmon,1998) found that teachers do not model the use of IT skills in their teaching., Eighty percent of teachers report that they do not feel well prepared to integrate technology with their teaching (National Center for Education Statistics, 1999). Little seems to have changed since the 1995 OTA report concluded, "Overall, teacher education programs in the U.S. do not prepare graduates to use technology as a teaching tool" (Office of Technology Assessment, 1995, p. 184).

The challenges of this were to design an online learning environment based on the following criteria:

- To meet the needs of K-12 teachers in helping them learn about technology integration issues
- To create a learning anytime and anywhere which is open entry and open exit
- To design a learning environment that could be used by teachers' current technology levels as well as technological resources, which are all extremely varied
- To design a learning environment that emphasizes the individual but promotes community
- To design a learning environment that integrates the latest research and pedagogical innovations into daily classroom practice
- To provide high quality resources for learning
- To enable teachers to enhance their knowledge for using technology in their subject area while addressing professional standards

The current emphasis on technology is to ensure that it is used effectively to create new opportunities for learning and to promote student achievement. Educational technology requires the assistance of educators who integrate technology into the curriculum, align it with student learning goals, and use it for engaged learning projects" (NCREL, 2000) "Teacher quality is the factor that matters most for student learning," note Darling-Hammond and Berry (1998). Therefore, professional development for teachers becomes the key issue in using technology to improve the quality of learning in the classroom.

To address this need, the LTTS is being developed to provide learning modules that help teachers learn to integrate technology to support student inquiry and problem solving. These learning modules are self-contained, problem-based learning packages where a learner is presented with a problem scenarios based on significant technology integration issues that they face today, such as learning how to choose Internet-based projects, design WebQuests, and evaluate information found on the Internet. The goal for solving the problem is related to the teachers' own classroom context. So the teacher may develop an Internet-based teaching unit for her own class, choose an appropriate technology for her own students' collaboration, or learn how to teach Internet search models to her students.

Considering the meaning of professional development in the technological age, Grant states:

> "Professional development goes beyond the term 'training' with its implications of learning skills, and encompasses a definition that includes formal and informal means of helping teachers not only learn new skills but also develop new insights into pedagogy and their own practice, and explore new or advanced understandings of content and resources. [This] definition of professional development includes support for teachers as they encounter the challenges that come with putting into practice their evolving understandings about the use of technology to support inquiry-based learning" (NCREL, 2000).

Additionally, the U.S. Department of Education (1995) set forth several related principles that professional development should meet, including:

- It should reflect the best available research and practice in teaching, learning, and leadership.

- It should enable teachers to develop further expertise in subject content, teaching strategies, uses of technologies, and other essential elements in teaching to high standards.
- It should promote continuous inquiry and improvement embedded in the daily life of schools.

In developing the LTTS, these professional development principles were considered as part of the design. Problem based learning was chosen as the methodology because of the strengths and advantages it offers for supporting teachers' professional development and learning. First, PBL builds on the use of teachers' research and practice in teaching and learning. Because the learner must address real classroom problems and issues using the latest research and other resources, they are connecting research to classroom teaching and practice.

Third, PBL provides a model of inquiry and investigation for teachers to learn not only for themselves but to apply to their own classroom practice. The PBL process requires that teachers address questions, make hypotheses, research and investigate issues, and develop a project that addresses the problem or issue.

In conclusion, the context for which this online PBL instructional design model was developed is critical to understanding the model itself. Other designers will perhaps need to adapt this model for their own particular contexts, but this will provide a starting place for their efforts.

Adapting PBL for a Web-Based Learning Anytime, Anywhere Environment

Since the LTTS is a web-based learning anytime anywhere environment, using problem based learning as a design framework required that we adapt PBL to work with this environment. This resulted in the development of a new instructional model. In making this adaptation, we considered the characteristics of web-based learning environment, the needs and characteristics of our learners, and their goal for using the LTTS.

First, several distance learning principles guided the development of this model. Since our learners are from diverse backgrounds, we cannot make common assumptions about them with regard to prior knowledge of technology integration and usage, knowledge of terms or current issues, or knowledge of inquiry based learning. So we designed a very structured PBL experience with built in scaffolding activities that help support the learner in solving the problem.

Second, finding high quality resources on the Web is a challenge for novices who do not know the research or current issues. Therefore, we provide some high quality resources to assist the learner in solving the problem. These resources are provided within activities as well as separately in a resources section. Also, learners are encouraged to find other high quality resources to use in solving the problem and contribute those to the system for others to use.

Third, the navigation of the Web can inhibit learning is it is too complex or difficult to use. If learners have to focus efforts on finding information or figuring out where to go next rather than learning, they can become quite frustrated. So we designed a navigational system that illuminates our PBL instructional model and process. In fact, in a usability test conducted with six teachers (Kirkley et. al., 2000), we found that teachers understood the PBL flowchart style navigation and liked its consistency.

With regard to adapting PBL for a learning anytime anywhere environment, several adaptations were made. First, a traditional PBL model typically includes collaborative group work and tutor and a facilitator who models higher order thinking and challenges the thinking of learners. In designing PBL for a Web-based format where learners are separated from each other and from the facilitator by time and space, there is a challenge for the instructional designers who want to apply PBL principles in developing online learning environment. This realization forced our design team to consider the ways in which learners and facilitators would want and need to communicate with each other.

In order to implement PBL on the Web, we explored the role that collaboration plays in the overall experience of PBL but within the framework of a learning anytime, anywhere environment. Within a face-to-face PBL framework, learners have active, group-based roles at some stage of the process for the purpose of determining solutions and synthesizing knowledge. In outlining PBL, Boud (1985) and Bridges and Hallinger (1992) emphasize the importance of a group role when learning stems from collaborative analysis of the problem and is largely learner-directed. Yet within a learning anytime, anywhere environment, it is difficult to set up a collaborative group experience. With open entry/open exit structure, learners are completing modules at their own pace. While learners can participate and discuss issues with other learners, collaboration would be extremely difficult.

The role of the facilitator in LTTS is flexible since the type of facilitator and location of the facilitator will depend on the learner's goals for completing a module. For example, if a learner is completing a module for graduate credit, he may work with a facilitator at that university in which credit is being obtained. If a learner is completing a module to receive continuing education credits, he may work with his state monitor who acts as facilitator. If a learner is completing a module to improve technology integration skills, he may work with his

district staff developer. With this design, facilitators will have difference backgrounds, goals, and expectations, so instruction and assessment must be well designed.

Studies of the cognitive and metacognitive processes of students during the initial problem analysis phase of PBL support the view that the role of group interactions in PBL is to facilitate activation and elaboration of students' existing knowledge and so encourage conceptual change through cognitive dissonance (De Grave, Boshuizen, and Schmidt, 1996). If this is the function of group interaction in PBL, then, provided that an alternative mechanism with an equivalent effect is introduced, it should be possible to design effective PBL for individual use.

Exploring the value of PBL experiences for individual rather than collaborative use may be justified by the fact that professional practice is situated in a variety of contexts including individual study as well as collaborative and competitive teams. Successful professional practice frequently depends upon individual's capacity to solve problems. Logically, educational experiences which develop that capacity should be valued. Individual PBL experiences may help to address the increasing interest in distance and flexible access to professional education and the increasingly successful technology integration (Albion and Gibson, 1998).

Thus, not diminishing the value of collaboration and facilitation, we have developed instructional design model for individual web-based PBL, using appropriate alternatives which will assist learners through the problem solving process. Gibson and Gibson (1995) describe an alternative approach in which a learner is engaged with a problem individually and prepares a written analysis of the problem in preparation for group interaction. Within LTTS, this is done through module navigation and visual format, the use of scaffolding approaches, such as breaking the larger problem into sub-problems, the inclusion of the heuristic aids, the integration of metacognitive self-assessment tools as well as various mechanisms for supporting cooperative work on the problem at a distance. All these elements are intended to assist the learner in the individual PBL web-environment.

Web-Based PBL Instructional Model

According to our PBL model, which is very similar to traditional PBL models (Barrows and Myers, 1993), the LTTS learner goes through the series of phases in order to finally generate a problem solution. The problem scenario begins with identification of key concepts from the content domain and a typical context in which the concepts might be used. This *Presentation Phase* is intended to situate the learner in the problem context and to begin the process of activating relevant prior knowledge. Additionally, it is in this phase that learners have the option of beginning to customize their interpretation of the problem to make the context as specific as possible.

The *Exploration Phase* provides opportunity for recall and reconfiguration of prior knowledge relevant to the specific problem and exploration of additional, content specific knowledge and 'experience' gained during problem solution. Learners have access to a collection of resources relevant to the concepts encapsulated in the problem. We want them to identify possible solutions and resources needed for understanding the problem.

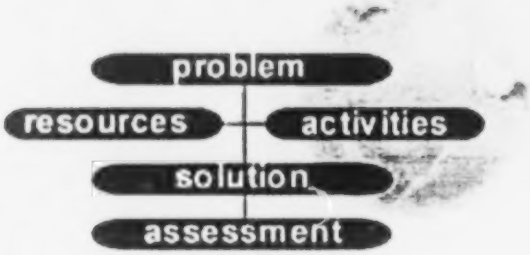
The *Integration Phase* emphasizes relevant knowledge transfer, analysis, integration, synthesis and evaluation of selected, content specific knowledge and problem based 'experience'. The problem in each module is divided into a series of tasks/sub-problems to facilitate scaffolding by considering the types of artifacts, typically documents of various kinds, which might be produced by the learner in association with a stepwise solution to the problem situation. Because PBL is intended to increase the capacity of learners to solve real problems and because identifying critical elements may be counter-productive, the learners are required judgment in selection from what is provided and initiative in employing material from alternative sources in order to be able to solve the problem. But we need to note that resource collection and analysis to some extent is embedded into each phase of the process.

The *Solution Phase* encourages learners to further integrate knowledge, 'experience' and artefacts gathered through the problem solving process into their cognitive structures as though products of real experience.

During the *Reflection Phase* learners are encouraged to conduct self-assessment of their artifacts assessing the content and organization of the learning modules according to the particular domain of technology integration.

Each learning module in the LTTS system is a self-contained, problem-based learning package, which presents a scenario, which includes a problem, resources, activities, solution, and assessment. The problem may ask the student to develop, design, or critique something such as an effective use of technology to meet a need, the resolution of an ethical dilemma, or the critique of a web interface. Students are asked to produce a product such as a report, or the development of an instructional plan or materials to address the problem. In all cases, the problem is flexible and enables learners to approach solving it from their own perspective and context. For example, rather than being given artificial scenarios, the learner solves the problem using the context of his or her own classroom. Each problem is authentic because it is related to a significant issue in the classroom today.

The module navigation scheme visually represents the problem solving process, and helps the learner organize working process.



The *Problem* section is intended to provide a situation description, a concrete and authentic context out of which arises a problem to be resolved or a project to be completed. It contains background information that helps establish the importance and broad relevance of the problem to the teaching and learning environment. The problem presentation contains enough information to make the problem intriguing, yet general enough to allow the learner freedom in determining the shape of the solution or product. The problem presentation includes a specific description of the role learner will adopt while working on the module. The problem needs to be important and containing motivating factors such as mystery, puzzlement, novelty, originality, and high relevance.

The purpose of the *Resources* section is to provide the learner with core materials that are of high quality and relevant to the problem. Our goal is for the learner to understand the resources as reflected in the learner's ability to apply them to the problem, which contrasts to the traditional learning environment that measures understanding by performance on a test rather than in the ability to apply concepts and principles. Module resources are primarily links to authentic materials (online research publications, projects web sites, online interviews, etc.) serving as a support to problem solving process. Resources may also include references to off-line materials such as books, magazines and videos. While we provide learners with a list of resources, we do not discourage them to use other materials they see as relevant and useful in the process of solving the problem.

Activities in problem-based LTTS module serve as scaffolded instruction that prepare the learner to develop problem-solving strategies. Due to the challenges of online environment, and considering the lack of instructor or facilitator, we divide problem into sub-problems or tasks that scaffold, model and coach the learner in his/her thinking and learning. Each activity is built around the issue relevant to the overall problem and includes links to resources presenting this issue. The learner is expected to complete a written analysis of some aspects of the problem for the purposes of synthesizing knowledge and determining solutions. All submitted works are stored in the system database and the learner has an access to them at the later stages while preparing the final product. The learner has an opportunity to modify and resubmit his/her work and retrieve his/her works in the *Solution* section in order to support the final product.

When the learner has completed the tasks specified in module *Activities* he/she is expected to prepare a final product, *Solution* for the problem. The solution can be prepared in the format of a paper, project, job-aid or instructional materials addressing the problem. The final product must address the major decisions that were made and should be based on or cite research, theory, or practice that grounds the decision making in the literature. In *Solution* section the learner has an opportunity to review his/her earlier work from Activities and create a final product.

The purpose of the *Assessment* section is to encourage and help structure the learner's reflection on his/her performance through a series of reflection questions. We recognize the importance of reflective questions for understanding the learners' thinking and assisting them move through the experience. In our design, we adopted the portion of Naidu and Oliver's PBL model (1996) that deals with reflection at multiple points in the process. We included two types of reflective questions that proved to be most important: check-up questions, and stepping back questions (Hmelo and Ferrari, 1997). Check-up questions are the ones that help students think about they goals as they work. In LTTS module these questions take the form of self-checks integrated into each activity. The second set of questions, stepping back, take the form of final reflection questions that ask the learners to reflect on the whole process of solving the problem. Reflection is considered a critical tool for synthesis as well as for facilitating students' forward motion in the problem environment (Orrill, 2000).

Reflection on the Instructional Model

Admittedly, the structure we used for web-based problem solving process is much more rigid than traditional face-to-face PBL environment. However, Abrami and Bures (1996) recognize that setting the agenda for students learning at a distance may be problematic since learners structure to help in planning and managing projects. This is

why we structured the problem solving process by dividing the problem into a set of sub problems, or activities. Wegner, Holloway, and Grader (1997) also confirm the need for structured support in their online PBL experience. Their issues focus on the development of particular content knowledge. They use some imposed structures such as process-oriented questions and lists of key terms and concepts in order to help their students move through the PBL experience and reach the desired outcomes. While this may have prevented the students from arriving at the "knowledge abstraction' phase of PBL (Barrows, 1985), it likely helps them stay on track to finishing the problem.

Compromising certain aspects of the problem-solving experience, we are also scaffolding learners to help them work in web-based environment. However, while proviiding more rigid structuring strategies we do not eliminate the most of the critical elements of PBL. A community of peers and a facilitator provide ongoing support to learners working on the problems individually. Corrent-Agostinho, Hedberg, and Lefoe (1998) emphasize that the most successful learning experiences are those in which the environment both structured and well facilitated.

The role of the facilitator is not to inform but to model higher order thinking and to challenge the thinking of learners (Boud, 1985; Savery and Duffy, 1995). Studies of student interaction with peers in the PBL environment (De Grave, Boshuizen, and Schmidt, 1996) suggest that exposure to different ideas in the group leads to conceptual change. The group interactions serve to encourage activation and elaboration of existing knowledge and integration of alternative views. Providing the style of support which the learner typically receives from the facilitator and peers in the face-to-face PBL environment presents an obvious challenge to the web-based PBL design. In our design, we are considering several options to satisfy the learners' need for group interaction and facilitation of their activities. The LTTS design team is developing various mechanisms (discussion forums, chat rooms) to support the process of building a community of learners interested in the similar problematic issues, discussing authentic experience, creating mentor-type relationships and teams to work together on the same problem. Another strategy, which would compliment the group interactions, is incorporating a feedback mechanism through which after completing a task th student will obtain access to a collection of responses containing varying interpretations of a problem. It is anticipated that exposure to a collection of responses in this way will have effects similar to interactions among a group of learners with differing vision of a problem and its solution. We hope to develop such an environment where the learner utilizing the individualized PBL model in a web-based learning environment will be able to receive both human and technology support.

At each stage of the design process, we used rapid prototyping techniques to ensure that the overall scenario was plausible and the problem process flowed naturally according to learners' perspective (Tripp and Bichelmeyer, 1990). This was done through having inservice teachers examine the modules in depth and make suggestions. Also, usability testing was conducted with six teachers, who are the real audience for LTTS.

Conclusion

This is a new instructional model for Web-based PBL. Obviously, it is not the same as traditional face-to-face PBL, and it is not our purpose to duplicate the traditional face to face PBL, which has the strengths of group collaboration. Our goal is to take the best of PBL learning and develop a new instructional model that would work within a Web-based learning anytime, anywhere environment. In doing this, we have to consider both the strengths and constraints of web-based instruction, learner characteristics, and the purpose of the LTTS, which is professional development. We need to understand the strengths and limitations of the online environment and learn how to operate within these. We also have to understand what aspects of PBL will work in these environments and will enhance professional development as well as how PBL needs to be adapted to fit the learning environment in which it occurs.

This instructional model is just one of many possible implementations of PBL on the Web. As communication technologies advance, there will be future instructional design models of PBL that are even more innovative. McLoughlin and Oliver (1999) argue that we need to develop online tools to support parallel problem solving, simulating course material, information exchange, database creation, and case-based projects. As new tools are created, instructional designers will need to develop enhanced instructional models that facilitate and support the inquiry and problem solving processes within the context of the areas being studied.

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